ULTRASOUND-GUIDED
FNA BIOPSY

AACE Advanced Thyroid Ultrasound and Fine Needle Aspiration Biopsy Course
Agenda

- Discuss current guidelines for UGFNA of thyroid nodule
- Review various techniques and tips used for thyroid nodule FNA
- Demonstrate common slide preparation methods
- Show videos of FNA procedures
Which Nodules Should Undergo Biopsy?

Guideline Recommendations
### Table 3. Sonographic and Clinical Features of Thyroid Nodules and Recommendations for FNA

<table>
<thead>
<tr>
<th>Nodule sonographic or clinical features</th>
<th>Recommended nodule threshold size for FNA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-risk history</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Nodule WITH suspicious sonographic features&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&gt;5 mm</td>
</tr>
<tr>
<td>Nodule WITHOUT suspicious sonographic features&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&gt;5 mm</td>
</tr>
<tr>
<td>Abnormal cervical lymph nodes</td>
<td>All&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Microcalcifications present in nodule</td>
<td>≥1 cm</td>
</tr>
<tr>
<td><strong>Solid nodule</strong></td>
<td></td>
</tr>
<tr>
<td>AND hypoechoic</td>
<td>≥1 cm</td>
</tr>
<tr>
<td>AND iso- or hyperechoic</td>
<td>≥1–1.5 cm</td>
</tr>
<tr>
<td><strong>Mixed cystic–solid nodule</strong></td>
<td></td>
</tr>
<tr>
<td>WITH any suspicious ultrasound features&lt;sup&gt;b&lt;/sup&gt;</td>
<td>≥1.5–2.0 cm</td>
</tr>
<tr>
<td>WITHOUT suspicious ultrasound features</td>
<td>≥2.0 cm</td>
</tr>
<tr>
<td>Spongiform nodule</td>
<td>≥2.0 cm&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Purely cystic nodule</td>
<td>FNA not indicated&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Divides nodules into three categories:

- **Probably benign**
  - Spongiform
  - Completely cystic or predominately cystic with comet tails
- **Suspicious for malignancy – Any feature present**
  - Taller than wide
  - Marked hypoechoic
  - Calcifications – micro or macro
  - Extracapsular extension (spiculated margin)
- **Indeterminate – Neither benign or suspicious features**
  - Iso, hypo or hyperechogenic
  - Ovoid to round or irregular shape
  - Smooth or ill-defined margin
  - Rim calcification
Biopsy based on category (and size)

Probably benign
- < 1cm - no f/u US needed
- > 1 cm – f/u US 2 y and 3-5 y
- > 2cm – Selective FNA biopsy

Suspicious for malignancy – Any feature present
- FNA biopsy all
- < 5mm – Selective FNA based on risk factors and experience
- > 5mm – All if feasible

Indeterminate – Neither benign or suspicious features
- < 1 cm – f/u US
- > 1 cm – FNA biopsy
- Growth – (20% diam or 50% volume) FNA biopsy
Fig. 1. Indications for FNA biopsy according to US findings. Suspicious US findings are markedly hypoechoic nodule, intranodular microcalcifications, more-tall-than-wide shape, and spiculated or lobulated margins. FNA = fine-needle aspiration; US = ultrasonography.
ATA 2015: Nodule Sonographic Pattern Risk of Malignancy

High Suspicion
70-90%
- microcalcifications
- hypoechoic nodule, irregular margin

Intermediate Suspicion
10-20%
- hypoechoic, irregular margins
- hypoechoic, taller than wide
- hypoechoic, irregular margins, extrathyroidal extension
- hypoechoic, interrupted rim calcification with soft tissue extrusion

Low Suspicion
5-10%
- hypoechoic solid regular margin
- hypoechoic solid regular margin
- hyperechoic solid regular margin
- isoechoic solid regular margin

Very Low Suspicion
<3%
- spongiform
- partially cystic no suspicious features
- partially cystic with eccentric solid area

Benign
<1%
- cyst

Haugen et al. Thyroid; Jan 2015
<table>
<thead>
<tr>
<th>Sonographic Pattern</th>
<th>Estimated malignancy risk</th>
<th>FNA size cutoff</th>
<th>Strength of rec</th>
<th>Quality of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>High suspicion</td>
<td>&gt;70-90%</td>
<td>≥ 1 cm</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
<tr>
<td>Intermediate suspicion</td>
<td>10-20%</td>
<td>≥ 1 cm</td>
<td>Strong</td>
<td>Low</td>
</tr>
<tr>
<td>Low suspicion</td>
<td>5-10%</td>
<td>≥ 1.5 cm</td>
<td>Weak</td>
<td>Low</td>
</tr>
<tr>
<td>Very low suspicion</td>
<td>&lt; 3%</td>
<td>≥ 2 cm</td>
<td>Weak</td>
<td>Moderate</td>
</tr>
<tr>
<td>Benign</td>
<td>&lt; 1%</td>
<td>No biopsy</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

One option is surveillance

FNA is not recommended for nodules that do not meet the above criteria, including all nodules < 1 cm

Haugen et al. Thyroid; January 2016
## US Risk and suggested FNA cutoffs

<table>
<thead>
<tr>
<th>Sonographic Pattern</th>
<th>Estimated malignancy risk</th>
<th>FNA size cutoff</th>
<th>AACE Level of Evidence</th>
<th>AACE Strength of Rec</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Risk US</td>
<td>50-90%</td>
<td>≥ 1 cm</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>Intermediate Risk US</td>
<td>5-15%</td>
<td>≥ 2 cm</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>Low Risk US</td>
<td>&lt;1%</td>
<td>≥ 2 cm or growing</td>
<td>2</td>
<td>A</td>
</tr>
</tbody>
</table>
Why use Size Criteria?

- Numerous studies confirm poor or no correlation between size and malignancy.
- However, the risk of metastasis (and therefore mortality) does have an association with size.
- “…attempts to diagnose and treat all small thyroid cancers in an effort to prevent these rare outcomes would likely cause more harm than good.” (ATA guidelines)

BUT – What do you tell the patient with a 8 mm probable cancer?
## 317 Thyroid Incidentalomas

<table>
<thead>
<tr>
<th>Size in cm</th>
<th>Number</th>
<th>Papillary cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;.5</td>
<td>25</td>
<td>3 (12%)</td>
</tr>
<tr>
<td>.5-.9</td>
<td>153</td>
<td>22 (15%)</td>
</tr>
<tr>
<td>1-1.5</td>
<td>139</td>
<td>18 (13%)</td>
</tr>
</tbody>
</table>

Nam-Goong, et al. 2004 *Clin Endocrinol*
Micronodule

Papillary Carcinoma

Suspicious features: Taller than wide, calcifications
Utility of Ultrasound in FNA
Goals of FNA

- Obtain an Adequate Specimen
- Sample the Area of Concern
- Provide Good Material for the Cytopathologist
- Minimize Patient Discomfort
- Make the Right Diagnosis!
Diagnostic Shortcomings

- Inability to assess capsular and vascular invasion with a cytological specimen
- Difficulties with predominantly cystic, highly vascular and calcified nodules
- Inconsistent expertise in interpretation as well as classification
- Poor sampling and improper slide making
Value of Ultrasound Prior to FNA

- Record the size and volume of the nodule
- Record nodule’s ultrasound characteristics
- Selection of needle size and length
- Selection of most suspicious nodules in MNG
- Detect other areas of suspicion
  - Lymph nodes, parathyroid adenoma, etc
- Determine if UG FNA is needed
Preparation

- Explanation of the procedure
- Proper patient position
- Room set-up
- Anti-septic – alcohol, betadine
- Anesthesia
  - None, Ice, Ethyl Chloride, Lidocaine
- Anxiety – pre-medication seldom needed
Pain with FNA

- FNA of thyroid nodules less painful than that of cervical lymph nodes
- Most tolerate the transient pain without the use of local anesthesia
- Using 25g needle/aspiration in 218 patients, FNA pain correlated with:
  - age <25 years, female sex, # nodules biopsied and anxiety

Lo WC et al. Head Neck, 2013 June
Leboulleux S et al. Thyroid 2013 Sep
Techniques to Minimize Discomfort

- Discuss procedure with patient
- Use smallest needle possible
  - 27 gauge for most FNAB
  - 22 for draining cysts
- Avoid sternocleidomastoid muscle
- Enter quickly through skin and then slowly advance
- Fine oscillation and rotation
- Local anesthesia is seldom required
Anticoagulation

- 593 patients undergoing US-FNA of neck – 788 total lesions
  - 2 hematomas in 144 on anticoagulant
  - 4 on 449 not on anticoagulant
- No significant difference between groups
- Bleeding complications are rare after thyroid nodule FNA
- Patients on aspirin, heparin, clopidogrel or coumadin undergoing neck FNA showed no increased bleeding risk

Anticoagulation

- Bleeding complications are rare after thyroid nodule FNA
- If patient on anticoagulant, consider 10 minute observation for hematoma formation
- Color Doppler to avoid/detect small vessels
- Denham showed does not impact adequacy of cytology

Denham et al. J Ultrasound Med. 2016 Jan
Novel Oral Anticoagulants

- Dabigatran (Pradaxa)
- Rivaroxaban (Xarelto)
- Apixaban (Eliquis)

Mayo Clinic Review: “Patients taking NOACs for stroke prevention in non-valvular a-fib and venous thrombosis prophylaxis do not need to stop therapy prior to or following US-FNA of nodules”

Lyle MA and Dean DS. Thyroid. April 2015
FNA vs. Core Needle Biopsy

- Rare reports of hemorrhage and tumor needle tracking with large CNB
- CNB requires anesthesia and increases local discomfort
- CNB does not consistently add significant accuracy or clarification for follicular neoplasms
- CNB may complement FNA in cases of FNA insufficient samples

NCI Thyroid FNA State of the Science Conference. Diagn Cytopathol 2008 Jun
Setting up for FNA
Needles
Needles

- 25-27 gauge needles for most nodules
- 22 gauge for drainage of cyst fluid if needed
- Most nodules can be accessed with 1.25-1.5” needles; 2.5” spinal needles are seldom needed
- Stylet needle if going through thyroid to target
  - Exophytic nodules, lymph nodes, etc
- Echogenic needles not needed
- Needle guides can be used, but generally unnecessary
Fragment of macrofollicle obtained through 27 gauge needle
Aspiration

- Pistol grip on syringe with tubing
  - Good for cyst drainage

- TAO Aspirator
  - Pre-set suction amount
  - Residual vacuum may bring material into syringe
Suction with assistant holding ultrasound probe
Aspiration Device
Aspiration device
Suction using extension tubing
Suction using extension tubing (cyst)
The merits of a simplified cytological method of fine needle sampling without aspiration are compared to those of the classical fine needle aspiration techniques in a series of benign and malignant mammary tumors which were subsequently proved histologically. A comparable cellular yield was obtained by both techniques. In a series of 635 benign and malignant breast tumors examined in 1981 with fine needle alone, insufficient cellular yield was recorded in 5.5% of the lesion. The same incidence (6%) was recorded with aspiration techniques in 7877 benign and malignant mammary tumors examined from 1954 to 1980. With the new technique, trauma is reduced and a better perception of the tumor and of its consistency is directly obtained.

Antoine Zajdela (1924-2013)

**Fig. 8.** Fine needle sampling without aspiration of a thyroid tumor.
Zajdela - Suctionless
Suctionless Zajdela Technique
Suctionless – Bare Needle
Suctionless – Bare Needle
Capillary Action - Zajdela

- Relies on forward motion of the needle as well as surface tension induced capillary action within the needle core (stronger with higher gauge)
- "Spinning" the free needle may improve yield
- May be done with needle only or needle attached to syringe w/o plunger
- Close system before withdrawing needle (cover hub or syringe end with thumb/hand)
Modified Capillary Action Set-up
Aspiration (FNA) vs. Capillary Action (FNC)

- In a palpation-biopsy study using 2 passes with each technique into 260 nodules, there was no difference in adequacy or accuracy.

- In an US-biopsy study, 88 nodules underwent FNA and 92 underwent FNC, again no difference between the techniques. Concluded that FNC may offer more technical ease.

Suction

- Larger volume of sample
- More blood
- Begin sampling once in target

- Avascular nodules
- Lymph nodes
- Parathyroids
- Complex cysts
- Drain cysts

Suction-less

- Smaller volume of sample
- Less blood
- Simpler

- Vascular nodules
- Superficial nodules
- Most nodules
Ultrasound Visualization for Fine Needle Aspiration Biopsy
Ultrasound-guided FNA Biopsy

- Variety of Aspiration Techniques
  - Parallel versus Perpendicular imaging
  - Syringe holder or not
  - Suction versus suctionless
- Have monitor clearly visible
- Echogenic needles not necessary
- Maximize cellular yield and minimize blood
  - Dwell time: Keep under 6-10 seconds
- Quality Slide preparation
Methods of Approach

parallel  perpendicular
Parallel Approach
Perpendicular Approach
Technique of Ultrasound-Guided FNA
Improving needle visualization

- Needle and transducer MUST line up
- Position yourself so can see relationship
  - Look down needle and transducer head
- Needle bevel up
- Make fine adjustments
  - Rotation and lateral movement
- Beam steering
- Echogenic needles rarely needed
- Practice, practice, practice.
Look for superficial vessels
Less transducer pressure to confirm
Pull Skin Tight

Don’t pass through US gel

Eyes on Monitor!
Dwell-Time

- First pass most likely to be best as hemorrhage begins to occur
- 2-5 seconds of back-forth motion
- Blood in hub: too long of a dwell time
- Position needle in the peripheral 2-5 mm of nodules undergoing cystic degeneration
Number of Passes

- If Rapid On-Site Evaluation (ROSE) available
  - 2-3 passes from different regions then assess
  - Additional passes if inadequate
    - Adequate: >6 groups of >=10 follicular cells
  - Additional passes for special studies

- Without ROSE
  - 2-8 passes from different sites (average 3-4 passes)
  - Either all in liquid transport OR slides with rinse into transport media
Special Situations

- Hypervascular nodules
- Peripherally calcified nodules
- Predominately cystic nodules
- Deep biopsy
Hypervascular Nodules

- Capillary action
- Reduce dwell time
- 1-2 Rapid thrusts after gentle positioning needle just outside the nodule
- Subsequent FNAs at different sites of nodule
Interrupted Eggshell FNA Approach

Kim DW. Clinical Imaging 2012, E-pub
Predominantly Cystic Nodules

- **Target Solid Component**

- **Direct needle into solid component without traversing the cystic part if possible**

- **Drain cyst fluid then FNA solid component**
  - Try w/one puncture (exchange syringe)
Spinal Needle for Deep Biopsy
Insufficient US-FNA Samples

- If a common problem (>10% of your samples):
  - Use ROSE to determine adequacy
  - Take an FNA/slide-making course
  - Alter technique(s)
  - Consider LBC

- Approach to Insufficient FNA
  - Repeat FNA if not benign US phenotype
  - Surgery if overt malignant US findings
  - Discuss w/ pathologist and observe select cases
  - Consider CNB if expert-repeat FNA still insufficient

Biopsy with Curvilinear Probe
Biopsy with Curvilinear Probe
Biopsy with Curvilinear Probe
Biopsy with Curvilinear Probe
Slide Preparation

- **Goals**
  - Monolayer Dispersion of cells
  - Avoid distortion or crush artifact
- Slides versus liquid based preparation
- Fixation and staining
  - Pap versus Wright Stain
  - Pathologist preference
36 SLIDES = TOO MUCH CLOT / BLOOD

OPA SLIDE GUIDELINES:

BX Cadence = 3 Seconds @ 3 / Second bml jsa

1 BX = 1 SLIDE (2 SLIDES BEGINNING; 1.5 SLIDES)

(> 2 = ? Suboptimal Bx Technique)
Smear Technique
Smear Technique
Let capillary action spread the sample out over the slides.
Pull Apart Like Opening a Book

Two Mirror Image Slides
1 → Alcohol Fix for Pap Stain
1 → Diff-Quik for On-Site Eval
Smear Technique – One step
Extracting sample from the needle and syringe

- Spray – Sample in needle
- Pop – (Excessive) sample in syringe
- Tap – Sample in syringe neck
- Flick – Sample in needle hub
- Rinse – For liquid based prep and for additional studies
  - TG, calcitonin, PTH, flow cytometry, genetics
SNAP TECHNIQUE

Tube & Slide Parallel

Pull Up

Release
Two Step Technique

Slides Joined
Parallel

Collected

Concentrated

Slide Vertical
Back Flow
Smear

| -------------------- First Step ------------------- |
| --- 2nd Step --- |
Two Step Technique

1 Step

2 Step
Rinsing material from the syringe
TG, Ct, PTH, Flow cytometry, DNA/RNA analysis, etc.
After the FNA

- Consider observation for 30 minutes post-procedure if needle >23 g, especially if CNB
- If on anticoagulant, observe for 10 minutes to confirm no hematoma formation
- If hematoma: ice and pressure; observe until stabilization confirmed
- Local pain/bruising: ice pack, acetaminophen
- Counsel patient of how results will be relayed
Biopsy Techniques - Summary

- Goal is acquisition of quality diagnostic material and presentation for cytology
- Achieve competency in several techniques to best fit the clinical need
- Avoid excessive dwell time and excessive blood on slides
- Good technique results in a quick and near painless procedure
- Prepare high quality slides